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AUTOMATIC REGULATION OF THERMOTECHNICAL OPERATING CONDITIONS FOR KILNS AND FURNACES

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Numerous opportunities exist in the refractories and ceramics industry for automatic regulation of thermotechnical operating conditions in kiln and furnace installations. Among the quantities which may be regulated are: temperature and moisture of gases, rate of gas flow, amount and pressure of steam, pressure of gaseous medium, etc.

Several types of modern automatic controllers used in these enterprises are described below.

The sensitive elements of the controllers usually consist of pyrometers, resistance and expansion thermometers, hygrometers, differential manometers, and others. These elements transmit an appropriate signal depending on manner of control data presentation, e.g., variations in EMF or pressure, thermal deformation, etc. The control data then actuates a regulating mechanism either by the direct or indirect action method. The indirect-action type are most commonly used in kiln and furnace operations since the signal transmitted by the sensitive element is usually too small for direct control.

Modern automatic controllers are designed for either two-position or proportional regulation. The former type, is quite satisfactory in a number of kiln applications. The latter type is commonly applied in furnace operations. In either case, the control mechanism may be activated by electrical, pneumatic, hydraulic or mechanical means, and furthermore, the controllers may be of the stationary (maintaining a parameter within certain narrow limits) or "programmed" type in which the parameter may be varied in a prearranged manner.

Direct-Action Type

The simplest type of direct-action controller utilizes an expansion thermometer acting on sensitive metallic bellows whose deformation is transmitted to a suitable value.

Indirect-Action Type

Two examples of indirect-action controllers used for temperatures under 150 degrees are the electrical and pneumatic instruments described below. In both types the sensitive element operates on the principle of expansion, as in the previous case. However, in the electrical type, the action of the bellows is transmitted to a two-position mercury contact switch. The switch, in turn, may be used to control electric motors or solenoids, either directly or through intermediate current amplifiers (relays). In the pneumatic type, the action of the bellows is transmitted by lever action to a slide value on a nozzle controlling the pressure in an air line which in turn activates pneumatic mechanisms. A two-shoulder lever arm provides reversible operation. Similar types of instruments may be used for controlling the humidity of air or gases.

Pneumatic Moisture Controller

The sensitive element consists of a special wooden strip whose expansion or contraction is transmitted to a moisture indicator by means of a lever system in which a strip of low expansion invar metal is used.

Automatic Potentiometers and Balancing Bridges

These types of instruments are used for accurate measurements and in cases requiring continuous temperature indication. The data presentation is achieved with thermocouples in the potentiometers, and with resistance thermometers in the bridges.

These instruments have the following disadvantages: complex mechanism, periodicity in operation, use of a galvanometer which must be protected from jarring, etc.

Electronic Amplifiers

In recent years in the USSR, the above difficulties were overcome by designing instruments with electronic amplifiers. These instruments are supplied with balancing motors of the two-phase induction type in which the current ceases to flow when equilibrium is achieved. That is, the EMF of the thermocouple or resistance thermometer is balanced out. The kinematic arrangement of the automatic potentiometer and balancing bridge, in conjunction with an electronic amplifier, is considerably less complex than for the same instruments with galvanometer and mechanical balancing.

Automatic Pneumatic-Type Controller

This type also provides smooth control of the regulating mechanism. The present tendency is to favor universal pneumatic controllers suitable for operation with resistance thermometers, pyrometers, manometers, discharge meters, hygrometers, etc.

A typical instrument of this type utilizes an expansion thermometer acting on a manometric-spiral which, in turn, activates the pointer and pen of the indicator mechanism. The spiral deflections are also transmitted by leverage to a special pneumatic device whose purpose is to make possible proportional control with continuous balance between the manometric thermometer and a pneumatic relay. The latter is designed to speed up the control action. This type of instrument is designed for stationary control.

Cycle Controllers

In order for the above instruments to operate with variable parameter control, the so-called cycle controllers were developed which can be used in series with either the electrical - or pneumatic-type instruments. This controller utilizes a rotating cam which varies the parameter control index by transmitting its motion through levers and an automatic reduction valve, in accordance with a prearranged program. The cam is driven by a motor or clockwork mechanism.

Other Types of Controllers

In addition to the above types, the following controllers are also commonly used: (1) pneumatic actuating mechanism with metallic bellows, used in lifting gate valves, opening dampers, etc; (2) solenoid-controlled valve mechanism; (3) diaphragm-type controller for regulating quantity of gas or steam (using a mercury manometer, electrical transmitting element and a balanced bridge); (4) controller operating on principle of float-type draft indicator.

The introduction of automatic processes in kiln and furnace operations results in higher operating standards, improved drying and firing conditions, simplifies and lightens functions of workers, and saves fuel. Therefore, serious attention should be devoted to problems of automatization in the refractories industry, using the reliable controllers manufactured in the USSR.

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